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(54) Process for producing modified polyisocyanurate foams

Verfahren zur Herstellung modifizierter Polyisocyanuratschaumstoffen

Procédé de préparation de mousses modifiées de polyisocyanurate

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(56) References cited:
EP-A- 0 132 057
EP-A- 0 585 636
FR-A- 2 128 440
US-A- 4 425 446

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Description

This invention relates to a process for producing a modified polyisocyanurate foam and, more particularly, to a process for producing a modified polyisocyanurate foam suitable for continuous production of laminate boards, insulation boards and the like which process does not involve the use of evaporating type blowing agent such as CFC, HCFC, HFC, pentane and methylene chloride.

It is known to produce a modified polyisocyanurate foam by reacting an organic polyisocyanate and a polyol in the presence of a blowing agent and using an trimerization catalyst and a carbodiimidation catalyst in combination (cf., for example, U.S. Patent No. 3,657,161). It has also been proposed to produce a modified polyisocyanurate foam by reacting an organic polyisocyanate and a polyol in the presence of a blowing agent and using methanol, furfuryl alcohol or phosphorene oxide (carbodiimidation catalyst) and an alkali metal salt (trimerization catalyst) in combination (U.S. Patent No. 4,166,164, and European Patent No. 381,324). U.S. Patent No. 3,887,501, U.S. Patent No. 3,928,256, U. S. Patent No. 3,998,776, U.S. Patent No. 3,994,837, U.S. Patent No. 3,981,829, U.S. Patent No. 3,994,839 and so on have reported a process for producing modified polyisocyanurate foam using a tertiary amine and an alcohol such as an amino alcohol as cocatalysts, a process in which a Mannich polyol, a phosphorus containing polyol or the like is used catalytically, a method in which s-triazine and phenol are used.

For producing these (modified) polyisocyanurate foams, it is a general measure to use flon as a blowing agent. However, the use of CFCs has a problem of breaking the ozone layer, and in near future the use of CFC and HCFC will be prohibited completely. While there is a possibility to use carbon dioxide gas generated by the reaction between water and isocyanate as a substitute for CFC, this is disadvatageous since increase in the amount of water with view to making low density foam leads to increase in the amount of urea bonds generated ($-NCO+H_2O \rightarrow -NH_2+CO_2\uparrow$, $-NH_2+OCN- \rightarrow -NHCONH-$), and therefore there arises a problem of giving only those foams that have low strength, deteriorated dimensional stability, and poor adherability with surface materials. Also, in the above-described conventional method using an trimerization catalyst and a carbodiimidation catalyst in combination, it is difficult to control the reaction when water is used as a blowing agent, and in particular, it is impossible to produce, at economically acceptable speeds, a low density rigid foam which has a free rise density of not more than 40 kg/m^3 and a density when molded, of not more than 60 kg/m^3, required for laminate boards or insulation boards.

US-A-4 425 446 discloses a process for the preparation of a rigid, closed cell, urea-modified isocyanurate foam, said process comprising reacting foam-forming reactants comprising multifunctional isocyanate, a polyol and water in the presence of isocyanurate polymerization catalysts. Representative examples of suitable isocyanurate polymerization catalysts are (1) tertiary amine catalyst such a substituted triazines, e.g. tri(dimethylamino propyl)triazine; (2) basic salts of weak organic acids such as alkali metal salts of alkanoic acids, e.g. potassium octoate and potassium hexoate; and (3) phospholines such as 3-methyl-1-phenyl-3-phospholine-1-oxide (Claim 1; column 4, lines 21-45).

EP-A-0 132 057 discloses a method for preparing a sprayable polymer composition which comprises mixing and reacting together substantially equal volumes of an A-side component and B-side component, wherein the A-side component comprises a mixture of 100 to 60 parts by weight of a methylene diisocyanate having an average functionality of less than 2.4 and 0 to 40 parts by weight of a polyether triol having a hydroxyl number of less than 50 or a prepolymer having free NCO groups obtained by reacting said methylene diisocyanate and said polyether triol and the B-side component comprises a mixture of from 50 to 95 parts by weight of a polyether triol having a hydroxyl number of less than 50, 5 to 40 parts by weight of a diol and a catalyst system comprising a trimerization catalyst when the A-side component comprises a mixture of methylene diisocyanate and polyether triol or a cream-time catalyst at least when the A-side component comprises a prepolymer and heat-activatable catalyst. The trimerization catalyst may be a potassium fatty acid salt, particularly potassium octoate. The heat-activatable catalyst may be an amine catalyst, particularly a diazabicycloundec-5-ene phenol blocked salt (Claims 1, 11, 13, 14).

FR-A-2 128 440 discloses that a trimerization catalyst may be chosen among a N,N',N"-trialkylaminoalkylhexahydrotriazine, such as N,N',N"-(dimethylaminopropyl)s-hexahydrotriazine, a mono(dialkylaminoalkyl)phenol, a 2,4,6-tri (dialkylaminoalkyl)phenol and their mixtures.

The present inventors made a study on a process which can industrially produce, from an organic polyisocyanate and a polyol without using any evaporating type blowing agent typified by CFCs, a modified polyisocyanurate foam of low density having a free rise density of not more than 40 kg/m^3 and a density when molded into a board (said density is hereinafter referred to as "density when molded into a board of 22 mm thickness"), of not more than 60 kg/m^3. As a result, it was found that by using a combination of two particular trimerization catalysts and a carbodiimidation catalyst together with water, a trimerization reaction of polyisocyanate, a carbodiimidation reaction of polyisocyanate, a reaction of polyisocyanate and water, etc. proceed quickly at a favorable balance, whereby a modified polyisocyanurate foam of low density having a free rise density of not more than 40 kg/m^3, preferably 20-40 kg/m^3 and a density when molded into a board, of not more than 60 kg/m^3, preferably 30-50 kg/m^3 can be obtained in a short time without using any evaporating type blowing agent such as CFC or the like. The finding has led to the completion of the present invention.

According to the present invention, there is provided a process for producing a modified polyisocyanurate foam,

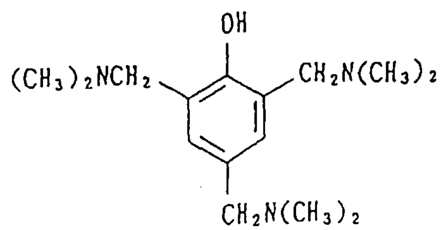
which process comprises reacting an organic polyisocyanate, a polyol and water in the presence of:

(a) a trimerization catalyst which is an alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid represented by formula (II)

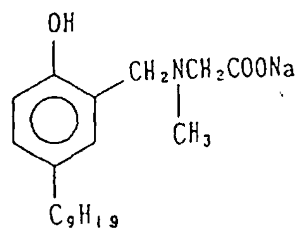
$$R_6\text{-COOM} \quad \text{(II)}$$

wherein R_6 is a hydrogen atom or a substituted or unsubstituted C_{1-7} aliphatic hydrocarbon group, and M is an alkali metal,

(b) a trimerization catalyst selected from compounds of formulas (IV), (V) or (VI)

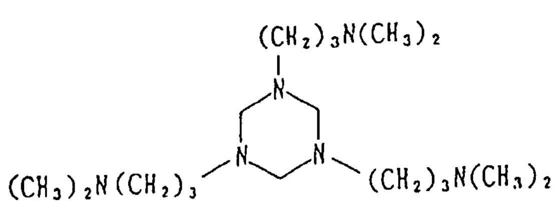


(IV)



(V)

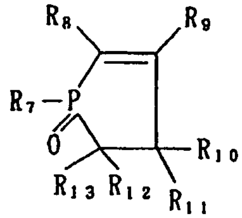
or



(VI)

and

(c) a carbodiimidation catalyst selected from the group of compounds consisting of phosphorene oxides represented by formulas (VII) and (VIII)



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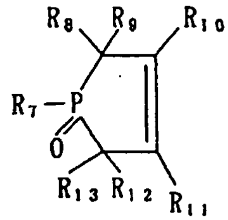


(VII) (VIII)

wherein R_7 is a substituted or unsubstituted alkyl, phenyl, naphthyl or benzyl group, and R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13} are each a hydrogen atom, a chlorine atom or a C_{1-4} alkyl group.

Hereinafter, this invention will be described in more detail.

The organic polyisocyanates used in the process of this invention as starting materials may be any of aliphatic, alicyclic, and aromatic types, and mixtures of these. Those conventionally used in the production of polyurethanes and polyisocyanurates can be used similarly. To be specific, suitable examples thereof include aromatic diisocyanates such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, crude tolylene diisocyanate, diphenylmethane diisocyanate, and crude diphenylmethane diisocyanate; aromatic triisocyanates such as 4,4',4"-triphenylmethane triisocyanate, and 2,4,6-tolylene triisocyanate; aromatic tetraisocyanates such as 4,4'-dimethyldiphenylmethane-2,2',5,5'-tetraiisocyanate, aliphatic isocyanates such as hexamethylene-1,6-diisocyanate; alicyclic isocyanates such as hydrogenated diphenylmethane diisocyanate; and other diisocyanates such as m-phenylene diisocyanate, naphthylene-1,5-diisocyanate, 1,-methoxyphenyl-2,4-diisocyanate, 4,4'-biphenyl diisocyanate, 3,3'-dimethoxy--biphenyl diisocyanate, and 3,3'-dimethyldiphenylmethane--diisocyanate. Among them, preferred are 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, crude tolylene diisocyanate, diphenylmethane diisocyanate, crude diphenylmethane diisocyanate, hexamethylene-1,6-diisocyanate, hydrogenated diphenylmethane diisocyanate, etc. The above-described organic polyisocyanates may be used singly or two or more of them may be combined.

The polyols include aliphatic, saccharide, aromatic compounds having two or more hydroxyl groups in the molecule, and mixtures thereof, such as polyether polyols, polyester polyols, and castor oil. Those conventionally used in the production of polyurethanes can also be used similarly. Those polyols may be of either lower molecular weight or high molecular weight. Specific examples thereof include, as polyether polyols, those compounds having structures of active hydrogen-containing compounds such as polyhydric alcohols, polyhydric phenols, amines, or polycarboxylic acids to which alkylene oxides are added. As the polyhydric alcohols, there can be cited, for example, dihydric alcohols such as ethylene glycol, propylene glycol, 1,4-butanediol, 1,6-hexanediol, diethylene glycol, and neopentyl glycol; trihydric or higher polyhydric alcohols such as pentaerythritol, and surcrose. As the polyhydric phenols, there can be cited, for example, polyhydric phenols such as pyrogallol, and hydroquinone; bisphenols such as bisphenol A; condensates of phenol and formaldehyde; and so on. As the amines, there can be cited, for example, ammonia, alkanolamines such as mono-, di- and triethanolamines, isopropanolamine, and aminoethylethanolamine; C_1-C_{22} alkylamines, C_2-C_6 alkylenediamines, polyalkylenepolyamines, aromatic amines such as aniline, phenylenediamine, diaminotoluene, xylenediamine, methylenedianiline, and diphenyletherdiamine, alicyclic amines such as isophoronediamine, and cyclohexylenediamine, heterocyclic amines, and so on. As the polycarboxcylic acids, there can be cited, for example, aliphatic polycarboxylic acids such as succinic acid, adipic acid, sebacic acid, maleic acid, and dimeric acid, aromatic polycarboxylic acids such as phthalic acid, terephthalic acid, trimellitic acid, and pyromelitic acid, etc. These active hydrogen-containing compounds may also be used as a mixture of two or more of them. As the alkylene oxides to be added to the active hydrogen-containing compounds, there can be cited, for example, propylene oxide, ethylene oxide, butylene oxide, tetrahydrofuran, etc. These alkylene oxides may be used singly or two or more of them may be used in combination. In the latter case, there may be blocked adducts or randomly added products. As the polyester polyols, there can be cited, for example, condensed polyester polyols obtained by the reaction between polyhydric alcohols (the aforementioned alcohols, trimethylolpropane, glycerol, etc.) and carboxylic acids (the aforementioned polycarboxylic acids, etc.), polyester polyols obtained by ring opening polymerization lactone, scrap PET to which ethylene oxide adduct of nonylphenol is added, and the like. Among them, aliphatic, aromatic, aliphatic or aromatic amine, pentaerythritol, or sucrose based polyether polyols; aromatic or aliphatic carboxylic acid polyester polyols; lactone polyester polyols; etc. are particularly preferred. The aforementioned polyols may be used singly or two or more of them may be used in combination.

The aforementioned polyols may have a hydroxyl number within the range of generally 20 to 600 mgKOH/g, preferably 25 to 500 mgKOH/g, more preferably 50 to 400 mgKOH/g.

According to the process of this invention, polyisocyanurate foams can be generated by the reaction of the aforementioned organic polyisocyanate with the aforementioned polyol together with water as a blowing agent. To perform the reaction, compounding proportions of the organic polyisocyanate, the polyol and water are not limited strictly, and may vary widely depending on desired physical properties and uses of final products of modified polyisocyanurate foams. Generally, it is preferred to react the aforementioned components after blending them such that isocyanate index expressed as NCO/OH equivalent ratio can become within the range of not below 1.8, preferably from 1.8 to 5, more preferably 2 to 4.

The amount of water to be used as a blowing agent can be controlled depending on the density and the like desired for final products of the modified polyisocyanurate foam. In particular, the process of this invention has a feature that a low density rigid foam can be produced by using only water and without using volatile blowing agents. According to the process of this invention, addition of water in amounts within the range of, for example, 0.3 to 1.8% by weight, preferably 0.8 to 1.5% by weight, based on the total weight of organic polyisocyanate, polyol and water enables production of a low density foam having a free rise density of generally not more than 40 kg/m^3, preferably 20-30 kg/m^3 and a density when molded into a board of 22 mm thickness, of generally not more than 60 kg/m^3, preferably 30-50 kg/m^3, with ease without using any volatile blowing agent.

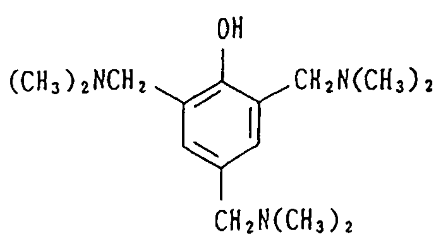
The present process is characterized in that the reaction for producing a modified polyisocyanurate foam from the above-mentioned polyisocyanate, the above-mentioned polyol and water is carried out in the presence of the following catalysts:

(a) a trimerization catalyst which is an alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid represented by formula (II)

$$R_6\text{-COOM} \qquad (II)$$

wherein R_6 is a hydrogen atom or a substituted or unsubstituted C_{1-7} aliphatic hydrocarbon group, and M is an alkali metal,

(b) a trimerization catalyst selected from compounds of formulas (IV), (V) or (VI)



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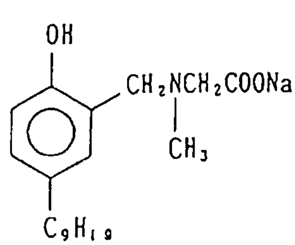
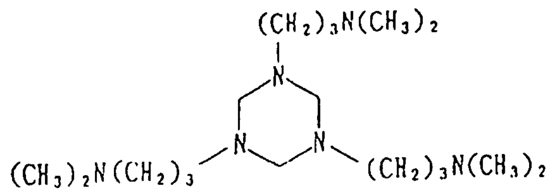


(V)

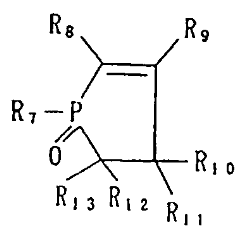
or



(VI)

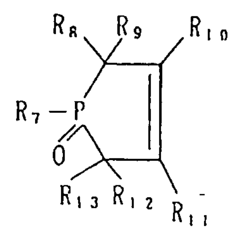
and

(c) a carbodiimidation catalyst selected from the group of compounds consisting of phosphorene oxides represented by formulas (VII) and (VIII)



(VII)

and



(VIII)

wherein R_7 is a substituted or unsubstituted alkyl, phenyl, naphthyl or benzyl group and R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13} are each a hydrogen atom, a chlorine atom or a C_{1-4} alkyl group.

These catalysts are described in more detail below.

Trimerization catalyst (a)

The alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid, of formula (II) used as the trimerization catalyst (a) is known per se as a catalyst used in production of polyurethane, polyisocyanurate, polyurethane-polyisocyanurate resin, etc. Specific examples thereof include the followings:

(1) Potassium acetate CH_3COOK

(2) Potassium 2-ethylhexanoate $CH_3CH_2CH_2CH_2CH(C_2H_5)COOK$

(3) Potassium propionate CH_3CH_2COOK

(4) Potassium formate $HCOOK$

(5) Potassium isobutyrate $(CH_3)_2CHCOOK$

(6) Potassium methacrylate $CH_2{=}C(CH_3){-}COOK$

(7) Potassium surbate $CH_3CH{=}CHCH{=}CHCOOK$

(8) Sodium acetate CH_3COONa

(9) Sodium 2-ethylhexanoate $CH_3CH_2CH_2CH_2CH(C_2H_5)COONa$

(10) Sodium propionate CH_3CH_2COONa

(11) Sodium butyrate $CH_3CH_2CH_2COONa$

(12) Sodium formate $HCOONa$

(13) Sodium caprylate $CH_3(CH_2)_6COONa$

Of these alkali metal salts of C_{1-8} aliphatic monocarboxylic acids, the compounds (1) and (2) are used preferably.

Trimerization catalyst (b)

Any of the compounds (IV), (V) and (VI) each used as the trimerization catalyst (b) is known per se as a catalyst used in production of polyurethane, polyisocyanurate, polyurethane-polyisocyanurate resin, etc.

Incidentally, the trimerization catalyst (a) used in the present process generally has a degree of trimerization of more than 15%, and the trimerization catalyst (b) generally has a trimerization ratio of not more than 15%. Herein, the degree of trimerization is a value measured by the method of C.M. Bartish et al. [SPI Summary, pp. 157-162 (1989)].

Carbodiimidation catalyst (c)

On the other hand, as for the compounds represented by the formula (VII) or (VIII) used in combination with the aforementioned trimerization catalysts (a) and (b), the alkyl group represented by R_7 may be either straight chain or branched chain, or partially substituted with halogen or other functional groups. Examples of such an alkyl group include methyl, ethyl, propyl, isopropyl, n-butyl, tert-butyl, 2-phenylethyl, 2-chloroethyl, 2-methoxyethyl, etc. groups. The substituted or unsubstituted phenyl, naphthyl and benzyl group include benzyl, phenyl, o-, p- or m-tolyl, xylyl, naphthyl, 4-diphenyl, o-, p- or m-chlorphenyl, etc. R_7 may preferably be a C_1-C_4 alkyl group, a phenyl group, or a benzyl group. The groups represented R_8-R_{13} of formula (VII) or (VIII) include hydrogen, chlorine, methyl, ethyl, propyl, isopropyl, butyl, etc., preferably hydrogen and methyl.

Specific examples of phosphorene oxide represented by formula (VII) or (VIII) include the following: 1-methylphosphorene oxide, 3-methyl-1-phenylphosphorene oxide, 3-methyl-1-benzyl-phosphorene oxide, 3-methyl-1-ethylphosphorene oxide, 3-methyl-1-ethylphenylphosphorene oxide, 1-phenyl-3-(4-methyl-3-pentenyl)phosphorene oxide, 1-phenyl-3-chlorophosphorene oxide, etc. Among these phosphorene oxides, especially 3-methyl-1-phenylphosphorene oxide, 3-methyl-1-phenyl-2-phosphorene oxide and 3-methyl-1-phenyl-3-phosphorene oxide are used suitably. These phosphorene oxides are known per se as a catalyst for accelerating the reaction for producing carbodiimide

linkage form organic isocyanates (cf., for example, U.S. Patent No. 3,657,161).

Production of modified polyisocyanurate foam

The present invention is characterized in that in producing a modified polyisocyanurate foam from an organic polyisocyanate, a polyol and water, there is used, as a catalyst, a combination of the three catalysts, i.e. the trimerization catalyst (a), the trimerization catalyst (b) and the carbodiimidation catalyst (c). By using a combination of the three catalysts, it has been made possible to industrially produce a modified polyisocyanurate foam of low density without using any evaporating type blowing agent such as CFC or the like which has problems.

The amounts of the trimerization catalyst (a), the trimerization catalyst (b) and the carbodiimidation catalyst (c) used are not strictly restricted and can be varied depending upon the reaction conditions used, etc. However, the preferable amount of the trimerization catalyst (a) is generally 0.1-10% by weight, particularly 0.5-5% by weight based on the weight of the organic polyisocyanate; the preferable amount of the trimerization catalyst (b) is generally 0.1-5% by weight, particularly 0.5-3% by weight on the same basis; and the appropriate amount of the carbodiimidation catalyst (c) is generally 0.05-5% by weight, particularly 0.1-2% by weight on the same basis.

The relative proportions of the trimerization catalyst (a) and the trimerization catalyst (b) and the relative proportions of [the trimerization catalyst (a) + the trimerization catalyst (b)] and the carbodiimidation catalyst (c) can be varied in a wide range depending upon the desired properties of final product, etc. However, the preferable weight ratio of [the trimerization catalyst (a)]/[the trimerization catalyst (b)] is generally 0.3/1 to 20/1, particularly 1/1 to 15/1. When the ratio is smaller than 0.3/1, the resulting foam has low curing, which adversely affects the production of boards; further, the resulting foam has a low trimerization ratio and consequently low flame retardancy. When the ratio is larger than 20/1, it is difficult to control the reaction and the resulting foam has inferior flowability. Specifically, the resulting foam has a high overpack ratio (50% or higher) [the overpack ratio indicates the proportions of a free rise density and a density when molded into a board and is defined by (density when molded into board/free rise density - 1) x 100] and has deteriorated properties in dimensional stability, etc.

The desirable weight ratio of [the trimerization catalyst (a) + trimerization catalyst (b)]/[the carbodiimidation catalyst (c)] is generally 1/1 to 25/1, particularly 2/1 to 15/1. When the ratio is smaller than 1/1, the resulting foam has a high overpack ratio. When the ratio is larger than 25/1, it is difficult to obtain a foam of low density. The overpack ratio is preferably 15-50%, particularly preferably 20-35%.

In the process of this invention, there can be used various additives in combination in amounts usually used. Such additives include, for example, urethanation catalysts (for example, triethylenediamine, dimethylethanolamine, triethylamine, trimethylaminoethylethanolamine, dimethylaminoethylether, pentamethyldiethylenetriaime, N-methyl-morpholine, dibutyltin dilaurate, tin octanoate, lead octanoate, etc.), surfactants (for example, dimethylsiloxane/polyether block copolymer, etc.), crosslinking and chain extender agent (for example, ethylene glycol, propylene glycol, 1,4-butanediol, 1,6-hexanediol, diethylene glycol, triethanolamine, diethanolamine, ethylenediamine, toluenediamine, etc.), flame retardants (for example, triphenyl phosphate, triethyl phosphate, trimethyl phosphate, cresyldiphenyl phosphate, tris (cresyl) phosphate, tris(chloroethyl) phosphate, tris(dichloropropyl) phosphate, tris(β-chloropropyl) phosphate, tris(β-chloroethyl) phosphate, tris(2,3-dibromopropyl) phosphate, tris(bromocresyl) phosphate, melamine, antimony triolxide, etc.), colorants, etc.

As the process for producing modified polyisocyanurate foams from the components described above, there can be cited, for example, a process in which first there are provided an isocyanate component composed of the aforementioned organic polyisocyanate or an isocyanate-terminated prepolymer component obtained by reacting an organic polyisocyanate with a polyol, and a polyol component composed of the above-described polyol, water, trimerization catalysts (a) and (b), and carbodiimidation catalyst, and optionally one or more of the urethanation catalyst, surfactant, crosslinking agent, flame retardant, colorant and other additives, and then upon use, the both components are put together, rapidly stirred and mixed. The resulting mixture is foamed and cured.

It is sufficient to set the reaction temperature at room temperature. In some cases, the reaction temperature may be elevated up to a temperature of about 90°C.

Hereinafter, this invention will be illustrated more concretely, by Examples.

Examples 1-11 and Comparative Examples 1-10

There were mixed 25 g of a polyol portion prepared by mixing a polyol, water, catalysts, a foam-controlling agent and a flame retardant in amounts shown in Table 1, and 75 g of crude MDI (diphenylmethane diisocyanate). The mixture was stirred by the use of a hand drill (2,200 rpm, agitating blade = 30 mm in diameter) for 5 seconds. 80 g of the resulting material was poured into a wooden case of 150 mm x 150 mm x 150 mm and measured for the cream time and rise time. The time from a liquid state to initiation of foaming was taken as the cream time, and the time to completion of foaming was taken as the rise time. One minute later, the foam was touched to judge the curing state of the surface.

The center portion of the cured foam was cut out in a size of about 100 mm x 100 mm x 100 mm, and the cut-out portion was measured for the volume and weight to calculate its free rise density.

To examine the flowability of foam, the same polyol portion and the same crude MDI were mixed and stirred in the same manner as above. 50 g of the resulting material was poured into a mold of 350 mm x 150 mm x 22 mm [one side (150 mm x 22) was open]. The cured foam was cut in a size of 200 mm x 150 mm x 22 mm, and the cut portion was measured for the volume and the weight to calculate its 22 mm t free rise density. Using a formula of [(22 mm t free rise density)/(free rise density) - 1] x 100, the overpack ratio of the cured foam was calculated.

The results are shown in Table 1. The values in parentheses in the table show the amounts of effective ingredients.

Table 1-1

	Example
	1
Polyol(1)	
Polyol A	16.0
Water	1.2
Catalyst(2)	
Trimerization catalyst (a)	
DABCO K-15	1.5 (1.07) -
Trimerization catalyst (b)	
Curithene 52	0.2 (0.1)

Table 1-1 (continued)

	Exampl
	1
Carbodiimidation catalyst	
3-Methyl-1-phenyl-2-phosphorene oxide	0.5
3-Methyl-1-phenyl-3-phosphorene oxide	
Surfactant(3)	0.5
Flame retardant(4)	5.1
Polyol component (total of the above)	25.0
Crude MDI	75.0
Isocyanate index	2.40
Cream time (sec)	11
Rise time (sec)	31
Curing state of one minute later	○
Free rise density (kg/m^3)	24.0
22 mm t free rise density (kg/m^3)	34.0
Overpack ratio (%)	42
[Trimerization catalyst (a)] / [Trimerization catalyst (b)]	10.7

Table 1-2

	Example									
	2	3	4	5	6	7	8	9	10	11
Polyol[(1)]										
Polyol A	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Catalyst[(2)]										
Trimerization catalyst (a)										
DABCO K-15	1.5 (1.07)	1.5 (1.07)				1.5 (1.07)	1.0 (0.71)	1.0 (0.71)	1.0 (0.71)	1.0 (0.71)
Polycat 46			2.0 (0.76)	2.0 (0.76)	2.0 (0.76)					
Trimerization catalyst (b)										
Polycat SA-1										
Polycat SA-102			0.2							
Curithene 52				0.2 (0.1)				1.5 (0.75)	1.0 (0.50)	0.8 (0.4)
DMP-30	0.1				0.1	0.5	1.0			
Polycat 41		0.1								
Urethanation catalyst										
DMEA									0.1	
TEDA										0.1

Table 1-2 (continued)

	Example									
	2	3	4	5	6	7	8	9	10	11
carbodiimidation Catalyst 3-Methyl-1-phenyl-2-phosphorene oxide	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3-Methyl-1-phenyl-3-phosphorene oxide										
Surfactant(3)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Flame retardant(4)	5.2	5.2	4.6	4.6	4.7	4.8	4.8	4.3	4.3	4.9
Polyol component (total of the above)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Crude MDI	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Isocyanate index	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
Cream time (sec)	8	10	11	12	9	6	5	12	10	10
Rise time (sec)	32	34	32	34	36	30	48	30	30	29
Curing state of one minute later	○	○	○	○	○	○	○	○	○	○
Free rise density (kg/m^3)	23.0	23.0	24.0	24.0	23.5	21.5	21.0	25.0	23.0	23.0
22 mm t free rise density (kg/m^3)	32.5	31.0	32.0	32.5	32.0	28.0	27.5	31.5	30.5	30.5
Overpack ratio (%)	41	37	33	35	36	30.0	31	26	33	33
[Trimerization catalyst (a)]/[Trimerization catalyst (b)]	10.7	10.7	3.8	7.6	7.6	2.14	0.71	0.95	1.42	1.78

Table 1-4

	Comparative Example									
	1	2	3	4	5	6	7	8	9	10
Polyol(1)										
Polyol A	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Polyol B										
Polyol C										
Polyol D										
Polyol E										
Water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Catalyst(2)										
Trimerization catalyst (a)										
DABCO TMR	1.5 (1.13)	1.5 (1.13)	1.5 (1.13)							
DABCO TMR 2										
DABCO K-15	0.8 (0.57)								1.5 (1.07)	
Polycat 46		0.5 (0.19)								
Trimerization catalyst (b)										
Polycat SA-1										
Polycat SA-102				1.6				1.6		
Curithene 52					2.0 (1.0)					2.0 (1.0)
DMP-30						2.2		0.5		1.0
Polycat 41							1.8			
Urethanation catalyst										
DMEA			0.3	0.2	0.3	0.1			0.3	
TEDA										

Table 1-4 (continued)

	Comparative Example									
	1	2	3	4	5	6	7	8	9	10
carbodiimidation Catalyst 3-Methyl-1-phenyl-2-phosphorene oxide	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5
3-Methyl-1-phenyl-3-phosphorene oxide										
Surfactant(3)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Flame retardant(4)	4.5	4.8	5.0	5.0	5.4	4.5	5.0	4.7	5.1	3.8
Polyol component (total of the above)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Crude MDI	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Isocyanate index	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
Cream time (sec)	9	10	8	6	8	3	4	5	8	11
Rise time (sec)	26	30	28	34	50	70	79	71	34	68
Curing state of one minute later	○	○	○	○	X	X	X	X	○	X
Free rise density (kg/m^3)	24.0	24.0	21.0	27.0	22.5	20.0	21.5	20.0	23.0	24.0
22 mm t free rise density (kg/m^3)	38.5	39.0	34.5	42.5	31.5	33.0	31.0	32.0	36.5	33.5
Overpack ratio (%)	60	63	64	57	40	65	44	60	59	40

Notes for Table 1

Polyol(1):

Polyol A: a phthalic acid type polyol having a hydroxyl value of 315 (APP-315 manufactured by Union Carbide)

Polyol B: a pentaerythritol type polyol having a hydroxyl value of 410 (410 NE manufactured by Asahi Glass Co., Ltd.)

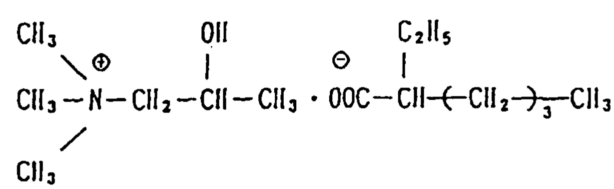
Polyol C: a sugar aromatic amine type polyol having a hydroxyl value of 410 (RX-403 manufactured by Sanyō Chemical Industries)

Polyol D: an aliphatic polyol having a hydroxyl value of 400 (GP-400 manufactured by Sanyo Chemical Industries)

Polyol E: an aliphatic polyol having a hydroxyl value of 28.5 (FA-718 manufactured by Sanyo Chemical Industries)

Catalyst(2):

DABCO TMR:



(trimerization catalyst, effective component = 75%)

DABCO TMR 2:

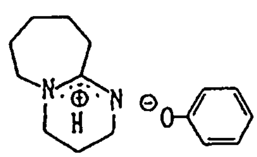
$$(CH_3)_3\overset{\oplus}{N}-CH_2-\underset{}{CH}(OH)-CH_3 \cdot \overset{\ominus}{O}OCH$$

(trimerization catalyst, effective component = 50%)

DABCO K-15: a solution of 70% potassium 2-ethylhexanoate in diethylene glycol (trimerization catalyst)

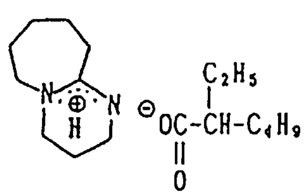
Polycat 46: a solution of 40% potassium acetate in ethylene glycol (trimerization catalyst)

Polycat SA-1:



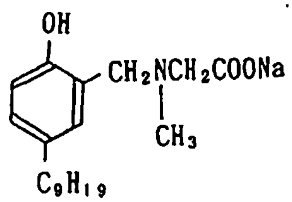
(trimerization catalyst)

Polycat SA-102:



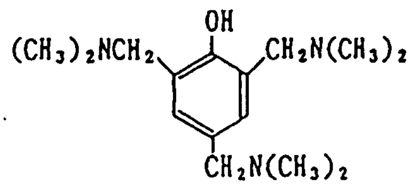
(trimerization catalyst)

Curithene 52:



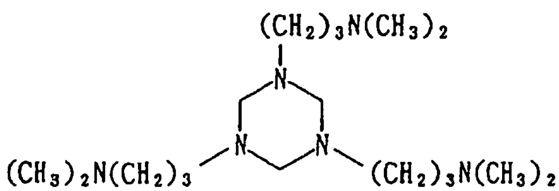
(trimerization catalyst, effective component = 50%)

DMP-30:



(trimerization catalyst)

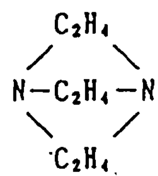
Polycat 41:



(trimerization catalyst)

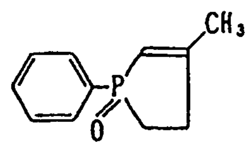
DMEA: $(CH_3)_2NCH_2CH_2OH$ (urethanation catalyst)

TEDA:



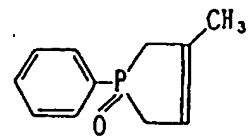
(urethanation catalyst)

3-Methyl-1-phenyl-2-phosphorene oxide:



(carbodiimidation catalyst)

3-Methyl-1-phenyl-3-phosphorene oxide:



(carbodiimidation catalyst)

Surfactant (3):
A dimethylsiloxane-polyether block copolymer (SZ-1627 manufactured by Nippon Unicar)

Flame retardant (4):
Tris(ß-chloropropyl) phosphate (Fyrol PCF manufactured by Akzo Kashima)

The free rise foams and the foams each molded into a 25 mm t board, obtained in Example 1 were measured for properties.

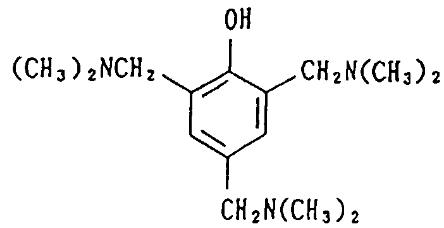
Claims

1. A process for producing a modified polyisocyanurate foam, which process comprises reacting an organic polyisocyanate, a polyol and water in the presence of:

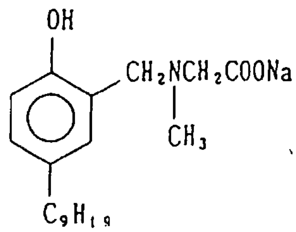
(a) a trimerization catalyst which is an alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid represented by formula (II)

$$R_6\text{-COOM} \qquad \text{(II)}$$

wherein R_6 is a hydrogen atom or a substituted or unsubstituted C_{1-7} aliphatic hydrocarbon group, and M is an alkali metal,
(b) a trimerization catalyst selected from compounds of formulas (IV), (V) or (VI)

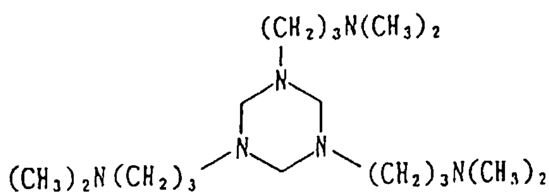


(IV)



(V)

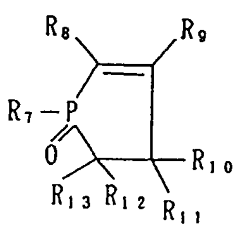
or



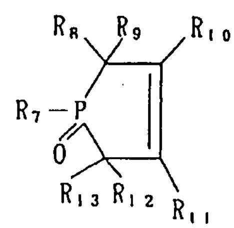
(VI)

and

(c) a carbodiimidation catalyst selected from the group of compounds consisting of phosphorene oxides represented by formulas (VII) and (VIII)



and



(VII)

(VIII)

wherein R_7 is a substituted or unsubstituted alkyl, phenyl, naphthyl or benzyl group and R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13} are each a hydrogen atom, a chlorine atom or a C_{1-4} alkyl group.

2. A process of claim 1, wherein the weight ratio of [the trimerization catalyst (a)]/[the trimerization catalyst (b)] is 0.3/1 to 20/1.

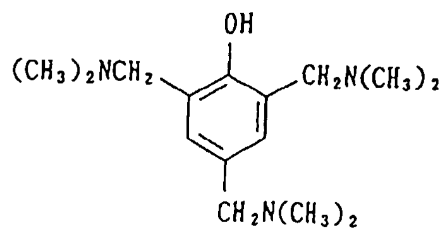
3. A process of claim 1, wherein the weight ratio of [the trimerization catalyst (a) + the trimerization catalyst (b)]/[the carbodiimidation catalyst (c)] is 1/1 to 25/1.

4. A catalyst for use in polymerization of isocyanate, which comprises:

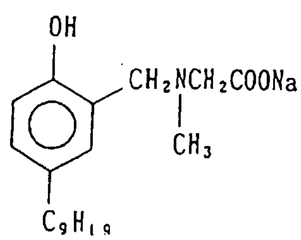
(a) a trimerization catalyst which is an alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid represented by formula (II)

$$R_6\text{-COOM} \qquad \text{(II)}$$

wherein R_6 is a hydrogen atom or a substituted or unsubstituted C_{1-7} aliphatic hydrocarbon group, and M is an alkali metal,
(b) a trimerization catalyst selected from compounds of formulas (IV), (V) or (VI)

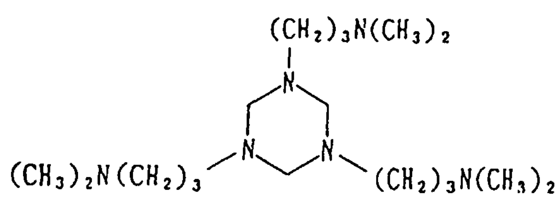


(IV)



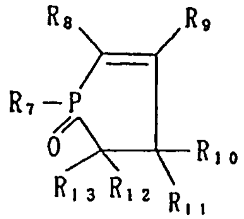
(V)

or



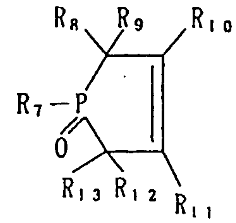
(VI)

and
(c) a carbodiimidation catalyst selected from the group of compounds consisting of phosphorene oxides represented by formulas (VII) and (VIII)



(VII)

and



(VIII)

wherein R_7 is a substituted oder unsubstituted alkyl, phenyl, naphthyl oder benzyl group, and R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13} are each a hydrogen atom, a chlorine atom or a C_{1-4} alkyl group.

5. A process of claim 1, wherein the alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid, represented by formula (II) is selected from the group consisting of potassium acetate, potassium 2-ethylhexanoate, potassium propionate, potassium formate, potassium isobutyrate, potassium methacrylate, potassium sorbate, sodium acetate, sodium 2-ethylhexanoate, sodium propionate, sodium butyrate, sodium formate and sodium caprylate.

6. A process of claim 5, wherein the alkali metal salt of a C_{1-8} aliphatic monocarboxylic acid, represented by formula (II) is potassium acetate or potassium 2-ethylhexanoate or sodium acetate.

7. A process of claim 1, wherein the trimerization catalyst (a) has a degree of trimerization of more than 15%.

8. A process of claim 1, wherein the trimerization catalyst (b) has a degree of trimerization of not more than 15%.

9. A process of claim 1, wherein said phosphorene oxide is a compound represented by formula (VII) or (VIII) in which R_7 represents a C_{1-4} alkyl group, a phenyl group or a benzyl group, and R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13} each represent independently a hydrogen atom, a chlorine atom, a methyl group, an ethyl group, a propyl group, an isopropyl group or a butyl group.

10. A process of claim 1, wherein said phosphorene oxide is selected from the group consisting of 1-methylphosphorene oxide, 3-methyl-1-phenylphosphorene oxide, 3-methyl-1-benzylphosphorene oxide, 3-methyl-1-ethylphosphorene oxide, 3-methyl-1-ethylphenylphosphorene oxide, 1-phenyl-3-(4-methyl-3-pentenyl)phosphorene oxide and 1-phenyl-3-chlorophosphorene oxide.

11. A process of claim 10, wherein said phosphorene oxide is 3-methyl-1-phenylphosphorene oxide.

12. A process of claim 1, wherein said trimerization catalyst (a) is used in an amount within the range of 0.1 to 10% by weight based on the weight of said organic polyisocyanate.

13. A process of claim 1, wherein said trimerization catalyst (b) is used in an amount within the range of 0.1 to 5% by weight based on the weight of said organic polyisocyanate.

14. A process of claim 1, wherein said carbodiimidation catalyst (c) is used in an amount within the range of 0.05 to 5% by weight based on the weight of said organic polyisocyanate.

15. A process of claim 1, wherein said organic polyisocyanate is selected from the group consisting of 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, crude tolylene diisocyanate, diphenylmethane diisocyanate, crude diphenylmethane diisocyanate, hexamethylene-1,6-diisocyanate, and hydrogenated diphenylmethane diisocyanate.

16. A process of claim 1, wherein said polyol is at least one polyol having a hydroxyl number within the range of 20

to 600 mgKOH/g.

17. A process of claim 1, wherein compounding proportions of said organic polyisocyanate, said polyol and said water are such that isocyanate index defined by NCO/OH equivalent ratio is not below 1.8.

18. A process of claim 1, wherein said water is used in an amount within the range of 0.3 to 1.8% by weight based on the total weight of said organic polyisocyanate, said polyol and said water.

19. A process of claim 1, wherein said modified polyisocyanurate foam has a free rise density of not exceeding 40 kg/ m^3.

20. A polyol composition comprising a polyol, water and said catalyst described in claim 4.

21. A modified polyisocyanurate foam produced by said process of claim 1.

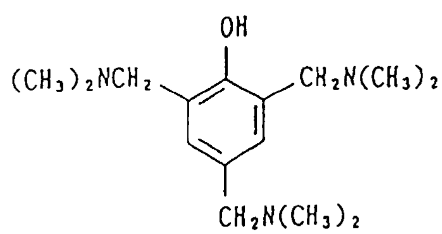
Patentansprüche

1. Verfahren zur Herstellung eines modifizierten Polyisocyanuratschaums, umfassend die Umsetzung eines organischen Polyisocyanats, eines Polyols und Wasser in Gegenwart von:

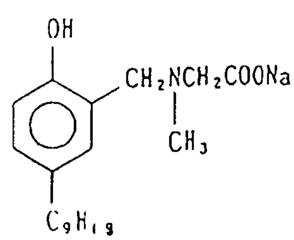
(a) einem Trimerisierungskatalysator, nämlich einem Alkalimetallsalz einer aliphatischen C_{1-8}-Monocarbonsäure der Formel (II)

$$R_6\text{-COOM} \qquad \text{(II)}$$

worin R_6 für ein Wasserstoffatom oder eine substituierte oder unsubstituierte aliphatische C_{1-7}-Kohlenwasserstoffgruppe steht, und M ein Alkalimetall ist;
(b) einem Trimerisierungskatalysator, ausgewählt aus Verbindungen der Formeln (IV), (V) oder (VI)



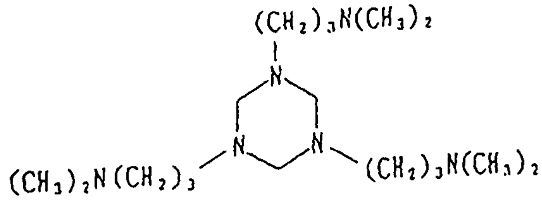
(IV)



(V)

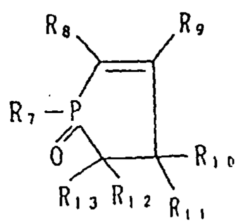
oder

(VI)

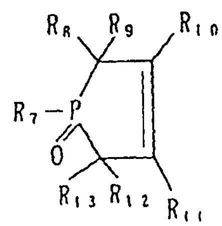


und

(c) einem Carbodiimidisierungskatalysator, ausgewählt aus der Gruppe von Verbindungen bestehend aus Phosphorenoxiden der Formeln (VII) und (VIII)



und



(VII) (VIII)

worin R_7 für eine substituierte oder unsubstituierte Alkyl-, Phenyl-, Naphthyl- oder Benzylgruppe steht, und R_8, R_9, R_{10}, R_{11}, R_{12} und R_{13} je für ein Wasserstoffatom, ein Chloratom oder eine C_{1-4}-Alkylgruppe stehen.

2. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß das Gewichtsverhältnis [Trimerisierungskatalysator (a)]/[Trimerisierungskatalysator (b)] 0,3/1 bis 20/1 beträgt.

3. Verfahren nach Anspruch 1, dadurch **gekennzeichnet**, daß das Gewichtsverhältnis [Trimerisierungskatalysator (a) + Trimerisierungskatalysator (b)]/[Carbodiimidisierungskatalysator (c)] 1/1 bis 25/1 beträgt.

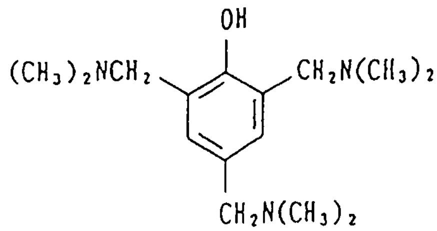
4. Katalysator zur Verwendung bei der Polymerisation von Isocyanaten, umfassend:

(a) einen Trimerisierungskatalysator, nämlich ein Alkalimetallsalz einer aliphatischen C_{1-8}-Monocarbonsäure der Formel (II)

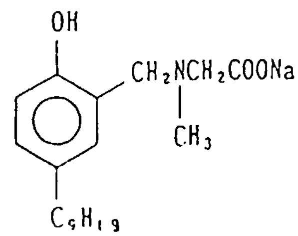
$$R_6\text{-COOM} \qquad \text{(II)}$$

worin R_6 für ein Wasserstoffatom oder eine substituierte oder unsubstituierte aliphatische C_{1-7}-Kohlenwasserstoffgruppe steht, und M ein Alkalimetall ist;

(b) einen Trimerisierungskatalysator, ausgewählt aus Verbindungen der Formel (IV), (V) oder (VI)

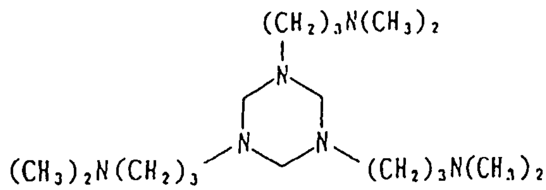


(IV)



(V)

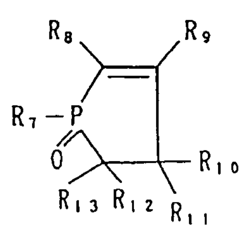
oder



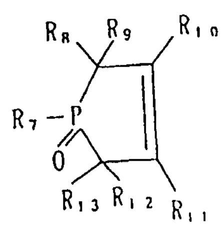
(VI)

und

(c) einen Carbodiimidisierungskatalysator, ausgewählt aus der Gruppe von Verbindungen bestehend aus Phosphorenoxiden der Formeln (VII) und (VIII)



und



(VII) (VIII)

worin R_7 für eine substituierte oder unsubstituierte Alkyl-, Phenyl-, Naphthyl- oder Benzylgruppe steht, und

R_8, R_9, R_{10}, R_{11}, R_{12} und R_{13} je für ein Wasserstoffatom, ein Chloratom oder eine C_{1-4}-Alkylgruppe stehen.

5. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß das Alkalimetallsalz der aliphatischen C_{1-8}-Monocarbonsäure der Formel (II) aus der Gruppe bestehend aus Kaliumacetat, Kalium-2-ethylhexanoat, Kaliumpropionat, Kaliumformiat, Kaliumisobutyrat, Kaliummethacrylat, Kaliumsorbat, Natriumacetat, Natrium-2-ethylhexanoat, Natriumpropionat, Natriumbutyrat, Natriumformiat und Natriumcaprylat ausgewählt wird.

6. Verfahren nach Anspruch 5, dadurch **gekennzeichnet,** daß das Alkalimetallsalz der aliphatischen C_{1-8}-Monocarbonsäure der Formel (II) Kaliumacetat oder Kalium-2-ethylhexanoat oder Natriumacetat ist.

7. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß der Trimerisierungskatalysator (a) einen Trimerisierungsgrad von mehr als 15% hat.

8. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß der Trimerisierungskatalysator (b) einen Trimerisierungsgrad von nicht mehr als 15% hat.

9. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß das Phosphorenoxid eine Verbindung der Formel (VII) oder (VIII) ist, worin R_7 für eine C_{1-4}-Alkylgruppe, eine Phenylgruppe oder eine Benzylgruppe steht, und R_8, R_9, R_{10}, R_{11}, R_{12} und R_{13} jeweils unabhängig für ein Wasserstoffatom, ein Chloratom, eine Methylgruppe, eine Ethylgruppe, eine Propylgruppe, eine Isopropylgruppe oder eine Butylgruppe stehen.

10. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß das Phosphorenoxid aus der Gruppe bestehend aus 1-Methylphosphorenoxid, 3-Methyl-1-phenylphosphorenoxid, 3-Methyl-1-benzylphosphorenoxid, 3-Methyl-1-ethylphosphorenoxid, 3-Methyl-1-ethylphenylphosphorenoxid, 1-Phenyl-3-(4-methyl-3-pentenyl)phosphorenoxid und 1-Phenyl-3-chlorphosphorenoxid ausgewählt wird.

11. Verfahren nach Anspruch 10, dadurch **gekennzeichnet,** daß das Phosphorenoxid 3-Methyl-1phenylphosphorenoxid ist.

12. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß der Trimerisierungskatalysator (a) in einer Menge im Bereich von 0,1 bis 10 Gew.-%, bezogen auf das Gewicht des organischen Polyisocyanats, eingesetzt wird.

13. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß der Trimerisierungskatalysator (b) in einer Menge im Bereich von 0,1 bis 5 Gew.-%, bezogen auf das Gewicht des organischen Polyisocyanats, eingesetzt wird.

14. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß der Carbodiimidisierungskatalysator (c) in einer Menge im Bereich von 0,05 bis 5 Gew.-%, bezogen auf das Gewicht des organischen Polyisocyanats, eingesetzt wird.

15. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß das organische Polyisocyanat aus der Gruppe bestehend aus 2,4-Tolylendiisocyanat, 2,6-Tolylendiisocyanat, rohem Tolylendiisocyanat, Diphenylmethandiisocyanat, rohem Diphenylmethandiisocyanat, Hexamethylen-1,6-diisocyanat und hydriertem Diphenylmethandiisocyanat ausgewählt wird.

16. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß das Polyol mindestens ein Polyol mit einer Hydroxylzahl im Bereich von 20 bis 600 mgKOH/g ist.

17. Verfahren nach Anspruch 1, dadurch **gekennzeichnet** , daß das Vermischungsverhältnis des organischen Polyisocyanats, des Polyols und des Wassers so ist, daß der durch das NCO/OH-Äquivalentverhältnis definierte Isocyanatindex nicht unterhalb 1,8 liegt.

18. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß das Wasser in einer Menge innerhalb des Bereichs von 0,3 bis 1,8 Gew.-%, bezogen auf das Gesamtgewicht des organischen Polyisocyanats, des Polyols und des Wassers, eingesetzt wird.

19. Verfahren nach Anspruch 1, dadurch **gekennzeichnet,** daß der modifizierte Polyisocyanuratschaum eine freie Steigdichte von nicht mehr als 40 kg/m^3 hat.

20. Polyolmasse, umfassend ein Polyol, Wasser und den in Anspruch 4 beschriebenen Katalysator.

21. Modifizierter Polyisocyanuratschaum, hergestellt durch das Verfahren nach Anspruch 1.

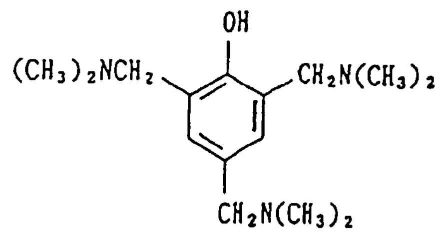
Revendications

1. Procédé pour produire une mousse de polyisocyanurate modifié, procédé qui consiste à faire réagir un polyisocyanate organique, un polyol et de l'eau en présence:

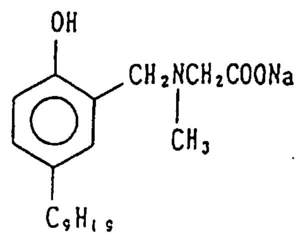
(a) d'un catalyseur de trimérisation qui est un sel de métal alcalin d'un acide monocarboxylique aliphatique en C_1 à C_8 représenté par la formule (II)

$$R_6\text{-COOM} \qquad \text{(II)}$$

dans laquelle R_6 représente un atome d'hydrogène ou un groupe d'hydrocarbure aliphatique substitué ou non substitué en C_1 à C_7, et M représente un métal alcalin,
(b) un catalyseur de trimérisation choisi parmi les composés de formules (IV), (V) ou (VI)

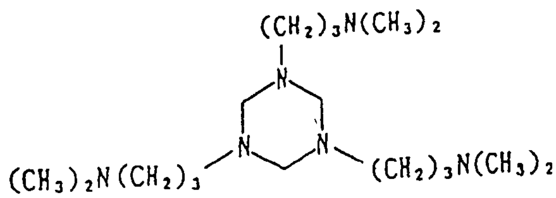


(IV)



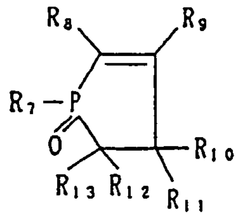
(V)

ou



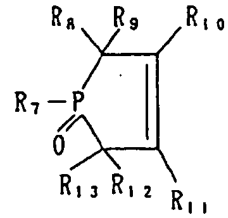
(VI)

et
(c) un catalyseur de carbodiimidation choisi dans le groupe formé par les composés constitués par les oxydes de phosphorène représentés par les formules (VII) et (VIII)



(VII)

et



(VIII)

dans lesquelles R_7 représente un groupe alkyle, phényle, naphthyle ou benzyle substitué ou non substitué, et R_8, R_9, R_{10}, R_{11} R_{12} et R_{13} représentent chacun un atome d'hydrogène, un atome de chlore ou un groupe alkyle en C_1 à C_4.

2. Procédé selon la revendication 1, dans lequel le rapport pondéral de [le catalyseur de trimérisation (a)]/[le catalyseur de trimérisation (b)] est de 0,3/1 à 20/1.

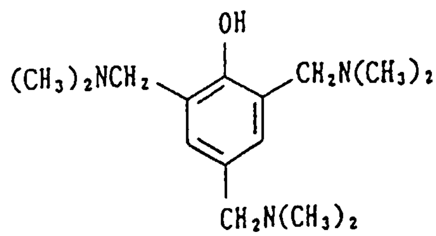
3. Procédé selon la revendication 1, dans lequel le rapport pondéral de [le catalyseur de trimérisation (a) + le catalyseur de trimérisation (b)]/le catalyseur de carbodiimidation (c)] est de 1/1 à 25/1.

4. Catalyseur pour une utilisation dans la polymérisation d'isocyanate qui comprend:

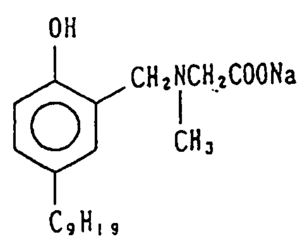
(a) un catalyseur de trimérisation qui est un sel de métal alcalin d'un acide monocarboxylique aliphatique en C_1 à C_8 représenté par la formule (II)

$$R_6\text{-COOM} \qquad \text{(II)}$$

dans laquelle R_6 représente un atome d'hydrogène ou un groupe d'hydrocarbure aliphatique substitué ou non substitué en C_1 à C_7, et M représente un métal alcalin,
(b) un catalyseur de trimérisation choisi parmi les composés de formules (IV), (V) ou (VI)

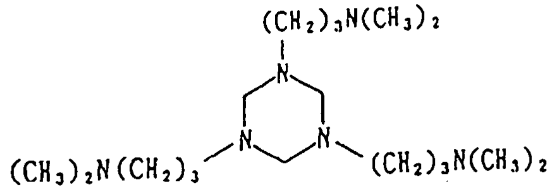


(IV)



(V)

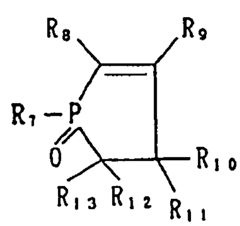
ou



(VI)

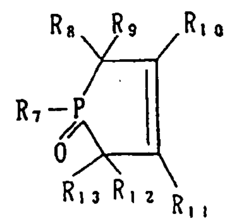
et

(c) un catalyseur de carbodiimidation choisi dans le groupe formé par les composés constitués par les oxydes de phosphorène représentés par les formules (VII) et (VIII)



(VII)

et



(VIII)

dans lesquelles R_7 représente un groupe alkyle, phényle, naphthyle ou benzyle substitué ou non substitué, et R_8, R_9, R_{10}, R_{11} R_{12} et R_{13} représentent chacun un atome d'hydrogène, un atome de chlore ou un groupe alkyle en C_1 à C_4.

5. Procédé selon la revendication 1, dans lequel le sel de métal alcalin de l'acide monocarboxylique aliphatique en C_1 à C_8, représenté par la formule (II) est choisi dans le groupe formé par l'acétate de potassium, le 2-éthylhexanoate de potassium, le propionate de potassium, le formiate de potassium, l'isobutyrate de potassium, le méthacrylate de potassium, le sorbate de potassium, l'acétate de sodium, le 2-éthylhexanoate de sodium, le propionate de sodium, le butyrate de sodium, le formiate de sodium et le caprylate de sodium.

6. Procédé selon la revendication 5, dans lequel le sel de métal alcalin d'un acide monocarboxylique aliphatique en C_1 à C_8, représenté par la formule (II) est soit l'acétate de potassium soit le 2-éthylhexanoate de potassium soit l'acétate de sodium.

7. Procédé selon la revendication 1, dans lequel le catalyseur de trimérisation (a) possède un degré de trimérisation supérieur à 15%.

8. Procédé selon la revendication 1, dans lequel le catalyseur de trimérisation (b) possède un degré de trimérisation ne dépassant pas 15%.

9. Procédé selon la revendication 1, dans lequel ledit oxyde de phosphorène est un composé représenté par les formules (VII) ou (VIII) dans lequel R_7 représente un groupe alkyle en C_1 à C_4, un groupe phényle ou un groupe benzyle, et R_8, R_9, R_{10}, R_{11}, R_{12} et R_{13} représentent chacun indépendamment un atome d'hydrogène, un atome de chlore, un groupe méthyle, un groupe éthyle, un groupe propyle, un groupe isopropyle ou un groupe butyle.

10. Procédé selon la revendication 1, dans lequel ledit oxyde de phosphorène est choisi dans le groupe formé par l'oxyde de 1-méthyl-phosphorène, l'oxyde de 3-méthyl-1-phénylphosphorène, l'oxyde de 3-méthyl-1-benzylphosphorène, l'oxyde de 3-méthyl-1-éthylphosphorène, l'oxyde de 3-méthyl-1-éthylphénylphosphorène, l'oxyde de 1-phényl-3-(4-méthyl-3-penténypl)phosphorène et l'oxyde de 1-phényl-3-chlorophosphorène.

11. Procédé selon la revendication 10, dans lequel ledit oxyde de phosphorène est l'oxyde de 3-méthyl-1-phénylphosphorène.

12. Procédé selon la revendication 1, dans lequel ledit oxyde de trimérisation (a) est utilisé à raison de 0,1 à 10% en

poids par rapport au poids dudit polyisocyanate organique.

13. Procédé selon la revendication 1, dans lequel ledit catalyseur de trimérisation (b) est utilisé à raison de 0,1 à 5% en poids par rapport au poids dudit polyisocyanate organique.

14. Procédé selon la revendication 1, dans lequel ledit catalyseur de carbodiimidation (c) est utilisé à raison de 0,05 à 5% en poids par rapport au poids dudit polyisocyanate organique.

15. Procédé selon la revendication 1, dans lequel ledit polyisocyanate organique est choisi dans le groupe constitué par le diisocyanate de 2,4-tolylène, le diisocyanate de 2,6-tolylène, le diisocyanate de tolylène brut, le diisocyanate de diphénylméthane, le diisocyanate de diphénylméthane brut, l'hexaméthylène-1,6-diisocyanate, et le diisocyanate de diphénylméthane hydrogéné.

16. Procédé selon la revendication 1, dans lequel ledit polyol est au moins un polyol possédant un indice d'hydroxyle dans la gamme de 20 à 600 mgKOH/g.

17. Procédé selon la revendication 1, dans lequel les proportions de formulation dudit polyisocyanate organique, dudit polyol et de ladite eau sont telles que l'indice d'isocyanate défini par le rapport d'équivalents NCO/OH n'est pas inférieur à 1,8.

18. Procédé selon la revendication 1, dans lequel ladite eau est utilisée en une quantité dans la gamme de 0,3 à 1,8% en poids par rapport au poids total dudit polyisocyanate organique, dudit polyol et de ladite eau.

19. Procédé selon la revendication 1, dans lequel ladite mousse de polyisocyanurate modifié possède une densité en expansion libre ne dépassant pas 40 kg/m^3.

20. Composition de polyol comprenant un polyol, de l'eau et ledit catalyseur décrit dans la revendication 4.

21. Mousse de polyisocyanurate modifié produite à l'aide dudit procédé selon la revendication 1.